Maternal Cardiac Disease in Pregnancy: What you need to know.

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MFM Methodist Health System
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CVD Objectives

• Describe cardiovascular changes in pregnancy and postpartum
• Identify risk factors for maternal cardiovascular disease
• Review changes to diagnostic criteria and interventions
• Recognize signs and symptoms of postpartum cardiovascular disease.
• Specify interventions to prevent or manage postpartum cardiovascular disease.

Part 1

Physiology

Antepartum Cardiac Changes

• Intravascular Volume
  • 50% increase in volume
  • 30% increase in RBC mass
    • 50% of this occurs by 20 weeks and is complete by 32 weeks
    • Further increase postpartum

• Stroke Volume
  • SV Peaks at 20 weeks

• HR
  • HR Peaks third trimester

• Circulation Time

Antepartum Cardiac Changes

• SVR and PVR
  • This is why BP drops

• Cardiac Output
  • Increases approx 50%
    • 50% of this change occurs by 8 weeks
    • 7 L/min

Disclosures

• No financial disclosures
**EKG Changes**

- Non specific T wave changes
- Left axis deviation
- Increased HR
- Increased QRS amplitude
- Intervals DO NOT CHANGE

**Intrapartum Cardiac Changes**

- First stage
  - 10-30% increase in CO
  - 8 L/min between contractions
  - 11 L/min during contractions
  - That is 1 L of blood pumped out of the heart every 5.5 seconds

- Second stage
  - 50% increase in CO
  - 300-500ml autotransfusion during contractions

**Postpartum Cardiac Changes**

- 80% increase in CO (from non pregnant state)

- 12-24 weeks before CO, SVR and stroke volume all normalize
  - CO normalizes in 6-12 weeks
  - SVR and SV take longer

**Part 2**

**Updates in HTN**

**Hypertension in Pregnancy**

- Published 2013
- ACOG Task Force
- Guidelines meant to serve as a foundation for care.

> "The guidelines are general and intended to be adapted to many different situations, taking into account the needs and resources particular to the locality, the institution, or the type of practice. Variations and innovations that improve the quality of patient care are to be encouraged rather than restricted. The purpose of these guidelines will be well served if they provide a firm basis on which local norms may be built."

**Endorsements**

- Society for Maternal-Fetal Medicine
- Preeclampsia Foundation
- American Society of Hypertension
- American Osteopathic Association
- American Optometric Association
- American Academy of Neurology
- American Academy of Physician Assistants
4 Categories

- Preeclampsia-Eclampsia
- CHTN
- CHTN with Superimposed Preeclampsia
- Gestational HTN

BP >140 systolic or 90 diastolic but less than 160 systolic and 110 diastolic

<table>
<thead>
<tr>
<th>Proteinuria</th>
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<tbody>
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<td>≥0.3 or 24 hr ≥ 300mg</td>
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Evaluate for severe disease
H&P, CBC, CMP, P:C or 24hr UA

Preeclampsia

<table>
<thead>
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No

**Ultrasound should also be performed to evaluate Fetus for IUGR and Oligohydramnios**

BP >160 systolic or 110 diastolic

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Evaluate for additional evidence of severe disease
H&P, CBC, CMP, P:C or 24hr UA

Preeclampsia with Severe Features

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Normal Blood Pressures with severe HA, RUQ pain or Visual Disturbances

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Evaluate for lab abnormalities
CBC, CMP, LDH or Haptoglobin

HELLP

**Unclear cause of symptoms continue evaluation**

No

Atypical Preeclampsia with Severe Features

<table>
<thead>
<tr>
<th>Preeclampsia with Severe Features</th>
</tr>
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<tbody>
<tr>
<td>Yes</td>
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</table>

No

24 y/o G1P0

- 33 weeks EGA by good dating
- New onset HA last evening, not remitting with tylenol or rest.
- Eyes closed, arm over face. Asked nurse to leave lights off.
- No edema, visual symptoms or RUQ pain.
- BP 158/94
- 2+ Protein on UA
Evaluating Neuro Symptoms

- Hardest part of diagnosing and managing
- Many have HA history
- No such thing as ‘typical’ preeclampsia HA
- Magnesium sulphate and Nifedipine are both a/d with HA
- Judgement call
- CT or MRI may show Posterior Reversible Encephalopathy
  - Expensive and often unnecessary way to confirm diagnosis
  - Typically use if less than 32 weeks
- Transfer to hospital with MFM

Next Steps

- Evaluate Fetus
  - Position
  - EFW
  - Doppler studies
- Complete evaluation of Mom
  - CBC, CMP, +/- Coags.
  - If CMP is abnormal, I ALWAYS get coags
- Report:
  - Cephalic
  - IUGR in the 8th percentile with normal Doppler studies
  - BPP 8/8

Mode/Means of Delivery

- Cervix is L/T/C

- What do you tell her? Any other tests you would like to do?
  - CST
  - Cervidil
  - C/S medically appropriate but would attempt VD

Management of Delivery and PP

- Magnesium sulphate throughout delivery process - if goes to OR, Mag should be continued through C/S
  - Continue for 24 hours PP
- In’s and Out’s Q 2-4 hours
- BP’s per protocol (Q1-2 hours)
- Continuous pulse ox
- Maintain mild HTN (140-150’s over 70-100’s)
  - Avoid hypotension
  - Treat severe HTN (≥160 systolic or ≥110 diastolic)
- Aggressive mgmt of blood pressure once PP

Recommendations for Management of Preeclampsia without severe features and Mild GHTN

- 37.0 weeks or greater
  - Deliver
- 34.0 weeks or greater with
  - ROM, Labor
  - Non-reassuring testing
  - IUGR <5th centile
  - Suspected abruption
  - Deliver

Outpatient Mgmt of Preeclampsia without severe features and Mild GHTN

- Less than 37.0 weeks without indication to deliver
  - Preeclampsia w/o Severe Features:
    - Twice weekly NST with AFI or weekly BPP
    - Weekly lab
    - Twice weekly BP check
    - Growth Q 3 weeks
  - Mild GHTN
    - Okay to perform single weekly NST
    - Second BP check may be performed in office or at home

- Recommend managing them identically. Difference in mgmt is minimal.
Treatment of Mild Gestational HTN
• BPs less than 160 systolic and less than 110 diastolic
• Antihypertensives should not be administered
• At delivery, IV magnesium sulphate for seizure prophylaxis is not required if there are no severe features
• Consider steroids for fetal lung maturity

Treatment of Severe Gestational HTN
• BPs greater than 160 systolic and/or 110 diastolic
• Without proteinuria or other signs of severe disease
• Antihypertensives should be administered
• Inpatient admission
• Magnesium sulphate for seizure prophylaxis
• Steroids for fetal lung maturity
• Only mgmt reference in 100pg guideline: “Hospitalize for severe gestational hypertension, severe fetal growth, or recurrent preeclampsia”

Diagnosis of Preeclampsia with Severe Features
• Severe BPs (≥160 systolic and/or 110 diastolic)
• LFTs 2x normal
• Cr ≥1.2
• Thrombocytopenia <100K
• Abruption
• Pulmonary edema
• Persistent cerebral symptoms
  • HA
  • Visual disturbances
  • Coagulopathy

Management of Preeclampsia with Severe Features
• Delivery is recommended at 34.0 weeks or greater
• If maternal/fetal condition is stable at <34.0 weeks then expectant mgmt can be considered. MFM consultation strongly recommended
• Delivery regardless of GA for:
  • Pulmonary edema, renal failure, abruption, DIC, severe thrombocytopenia, non-reassuring fetal testing, persistent cerebral symptoms or fetal demise

Recommended medications for antepartum treatment of CHTN

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage/Prep</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labetalol</td>
<td>200-400 mg/d orally or IV to 3x divided doses</td>
<td>May alter BP, control HTN and reduce need for catheter placement</td>
</tr>
<tr>
<td>Nifedipine</td>
<td>20-80 mg/d orally or IV, up to 3x divided doses</td>
<td>Do not use sublingual form</td>
</tr>
<tr>
<td>Methyldopa</td>
<td>0.5-1 g orally in 2x divided doses</td>
<td>Childhood safety data up to 7 years of age, may not be as effective in control of severe hypertension</td>
</tr>
</tbody>
</table>
Diagnosis of Superimposed Disease

Two Categories:

1. Superimposed
2. Superimposed with severe features

Management of CHTN with Superimposed Preeclampsia

- Need CBC, CMP and 24 hour urine for protein and creatinine clearance early in pregnancy. (P:C also acceptable but 24 hour preferred)
  - This aids in identifying disease progression later in pregnancy.
  - Doubling of proteinuria is considered indicative of superimposed disease.
  - Unsure what doubling of P:C means.
  - Maintain mild range BPs with medication if needed
  - Inpatient care

Management of Superimposed Disease

For women with superimposed preeclampsia with severe features, important management beyond 34-35 1/2 weeks of gestation is not recommended.

Answers to Frequently Asked Questions

There is no longer a ‘severe’ proteinuria criteria

- Oligohydramnios
- Severe IUGR <5th%

Answers to Frequently Asked Questions

- Magnesium sulphate should not be withheld if severe BPs normalize; whether through treatment or epidural.
  - Seizures are due to endothelial injury resulting in cerebral edema and PRES.
  - Seizures can occur independent of HTN
    - Estimated 15% of seizures occur in patients who are not hypertensive

Answers to Frequently Asked Questions

- Magnesium Sulphate should be administered to patients with severe HTN, preeclampsia with severe features, superimposed preeclampsia and HELLP syndrome.
  - Recommended regimen: 4-6 bolus and 1-2g per hour
  - Magnesium sulphate should be continued intraoperatively and for at least 24 hours post delivery for seizure prophylaxis.
  - This is a Methodist Labor and Delivery guideline

- If patients are admitted postpartum with severe HTN, preeclampsia with severe features, superimposed preeclampsia or HELLP syndrome and have normal renal function they should be given Magnesium Sulphate for at least 24 hours for seizure prophylaxis.

- Magnesium Sulphate is renally cleared and dosing should be adjusted for patients with renal impairment.
Discussion and Questions

Time for a break

Part 3
Why this all matters

Introduction

Why is Maternal Mortality going up?
- Data
  - How we collect data, maybe we are collecting better data? More states participating? Use of electronic resources?
- Patients
  - Change in rate of obesity in the US mirrors the change in maternal mortality
  - Women are choosing to bear children at older ages
    - Likely have more medical comorbidities
  - Increased use of infertility treatment
    - MMR related to IVF pregnancy: 42.5/100,000

Obstetric Care
- Profit driven health care system
  - Everyone is a "High Risk Obstetrician"
  - A lot of first listings on a Yahoo search are Ob/Gyn physicians
- Lack of contraception access
- Abortion restrictions

What is a Maternal Death
- CDC is counting direct maternal deaths
  - Includes up to 12 months after the pregnancy
  - System relies on voluntary submission of death certificates
- Direct versus indirect maternal mortality
  - Direct- pregnancy resulted or contributed to cause of death
    - Heart failure, MI, influenza
  - Indirect- Died while pregnant
    - Car accident, violence

Published in Washingtonpost based on WHO data in 2015.

https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pmss.html

U.S. lags behind other rich nations on maternal mortality

<table>
<thead>
<tr>
<th>Country</th>
<th>Maternal deaths due to pregnancy or labor complications per 100,000 live births, OECD countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>10</td>
</tr>
<tr>
<td>France</td>
<td>5</td>
</tr>
<tr>
<td>Germany</td>
<td>25</td>
</tr>
<tr>
<td>Japan</td>
<td>5</td>
</tr>
<tr>
<td>Sweden</td>
<td>5</td>
</tr>
<tr>
<td>Other OECD</td>
<td>5</td>
</tr>
</tbody>
</table>

Introduction


<table>
<thead>
<tr>
<th>Year</th>
<th>Maternal mortality rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>17.8</td>
</tr>
<tr>
<td>2000</td>
<td>14.6</td>
</tr>
<tr>
<td>2003</td>
<td>11.8</td>
</tr>
<tr>
<td>2006</td>
<td>8.9</td>
</tr>
<tr>
<td>2009</td>
<td>7.8</td>
</tr>
<tr>
<td>2012</td>
<td>5.8</td>
</tr>
</tbody>
</table>

Note: Number of pregnancy-related deaths per 100,000 live births per year.

https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pmss.html
Breakdown of All Deaths

Timing and Ethnicity of All Deaths

Timing Related to Cause

All Deaths

Can we make a difference in CVD?

Diving into the Numbers of Deaths due to CVD
CA-PAMR Top 5 Causes of Death 2002-2006 (N=257)

<table>
<thead>
<tr>
<th>Grouped Cause of Death, per CA-PAMR Committee</th>
<th>Pregnancy-Related Deaths N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular disease</td>
<td>64 (25)</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>42 (16)</td>
</tr>
<tr>
<td>Other cardiovascular</td>
<td>22 (9)</td>
</tr>
<tr>
<td>Preeclampsia/eclampsia</td>
<td>45 (18)</td>
</tr>
<tr>
<td>Obstetric hemorrhage</td>
<td>25 (10)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>23 (9)</td>
</tr>
<tr>
<td>Venous thromboembolism</td>
<td>22 (9)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>257</td>
</tr>
</tbody>
</table>

CA-PAMR Findings: California Pregnancy-Associated Mortality Review
Identification and Confirmation of CVD Pregnancy-Related Deaths 2002-2006

- California Birth Cohort, 2002-2006 N=2,741,220
- Pregnancy-Associated Cohort N=864
- Pregnancy-Related Deaths N=257
- Cardiovascular Pregnancy-Related Deaths N=64
- Cardiomyopathy N=42, 1 in 6 deaths in CA
- Other Cardiovascular N=22

CVD Pregnancy-Related Mortality Rate: 2.4 deaths /100,000 live births

Other Cardiovascular Disease Subtypes 2002-2006
- Pulmonary Hypertension (N=7)
- Aortic Dissection (N=6)
- Unexplained Sudden Death, probable arrhythmia (N=3)
- Non-Valvular, congenital (N=3)
- Coronary Artery Disease (N=2)
- Valvular Disease (N=2)

Identifying CVD in the Antepartum or Postpartum Setting

Who is at risk?

- History
  - Age >40
  - African American
  - Obesity (pre-preg BMI >35)
  - Pregestational DM
  - HTN
  - Preeclampsia
  - Substance abuse
    - Particularly stimulants
  - History of chemotherapy
    - Esoteric risk factor
    - Anthracyclines

What about the other 22?
Red flags by patient history

- Review of Symptoms
  - Dyspnea
  - Orthopnea
  - Tachypnea
  - Asthma unresponsive to tx
  - New Cough
  - Palpitations
  - Syncope/near syncope, dizziness
  - Chest pain

All of the information on the last 2 slides can be obtained without seeing the patient.

Case Presentation

25 y/o G2P2 African American calls 10 days postpartum with complaint of worsening fatigue and cough since day before discharge after a vaginal delivery.

Pregnancy was complicated by severe preeclampsia.

You pull up her chart and she went home on no meds. You note she had elevated blood pressures day of discharge (mostly 140 systolic and 80-90’s diastolic).

What is your differential?

- PP preeclampsia
- Cardiomyopathy
- Pulmonary edema
- Pneumonia
- Other infection
- Other cardiac
- Normal (not until pathology excluded)

What questions do you ask her?

Red flags, exacerbating factors

Back to the factors we looked at earlier

- Dyspnea
  - Stairs? How far can you walk?
- Orthopnea
  - Sleeping on the couch or in a chair/recliner?
- Tachypnea
  - Listen to how she speaks. Does she stop every few words to breathe?
- Asthma unresponsive to tx
- New Cough
  - Productive? Dry? Does anything make it worse? Activity, change in position?
- Palpitations
  - Heart pounding in chest/ear? Skip a beat? Feel fast?

Red flags, exacerbating factors

- Syncope/near syncope, dizziness
  - Does she have to sit down with minimal activity or feels lightheaded with minimal activity.
- Chest pain
- Prior ER admissions or office visits?
- Substance abuse?
  - Tobacco, cocaine, methamphetamine
- Did you have preeclampsia or high blood pressure?
  - We already know this information.
- Any history of breathing problems?
- Any history of heart disease or surgery?
Start categorizing patient’s symptoms as they answer questions

NYHA Classification of CVD

<table>
<thead>
<tr>
<th>Class</th>
<th>Patient Symptoms (Subjective)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No limitations of physical activity. Asymptomatic with ordinary activity.</td>
</tr>
<tr>
<td>II</td>
<td>Slight limitation of physical activity. Comfortable at rest. Ordinary activity quickly causes fatigue palpitations and/or dyspnea.</td>
</tr>
<tr>
<td>III</td>
<td>Marked limitation of activity. Comfortable at rest. Less than ordinary activity causes symptoms.</td>
</tr>
<tr>
<td>IV</td>
<td>Unable to perform any activity without discomfort. Symptoms of HF at rest. Activity exacerbates symptoms.</td>
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NYHA Classification

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<tr>
<th>Class</th>
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<tr>
<td>A</td>
<td>No evidence of CV disease. No symptoms or limitation to ordinary activity.</td>
</tr>
<tr>
<td>C</td>
<td>Objective evidence of moderately severe cardiovascular disease. Marked limitation in activity due to symptoms, even during less than ordinary activity. Comfortable only at rest.</td>
</tr>
<tr>
<td>D</td>
<td>Objective evidence of severe cardiovascular disease. Severe limitations. Experiences symptoms even while at rest.</td>
</tr>
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</table>

What to do next?

• Sounds like you said the same thing twice with slightly different words……..

• Examples:
  - A patient with minimal or no symptoms but a large pressure gradient across the aortic valve or severe obstruction of the left main coronary artery is classified:
    - Function Capacity I, Objective Assessment D
  - A patient with severe anginal syndrome but angiographically normal coronary arteries is classified:
    - Functional Capacity IV, Objective Assessment A

Acuity

• This is an emergent situation, and should be sent to an ER
  - Do not wait until the next day to evaluate in the office or send to urgent care
  - Urgent care does not have appropriate resources to evaluate properly. May result in delay of diagnosis.

• Minimal Evaluation in ED:
  - Vitals
    - CBC
    - CMP
    - EKG
    - Chest X-ray
    - BNP

Report from the ED

• BPs 140-170’s over 100-120’s. Sats 90-93%. 100% on 4L by NC. HR 120-130’s. RR 24. Afebrile.
• Hgb 9.8g/dL, Ptt 105,000
• Creatinine 1.2
• LFTs 2-3x normal
• BNP 745
• EKG: sinus tach with tall p-wave in Lead II
• CXR with increased pulmonary congestion and small pleural effusions bilaterally. RLL consolidation cannot rule out pneumonia.
**CVD Assessment Algorithm**
For Pregnant and Postpartum Women

<table>
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<th>Red Flags</th>
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<tbody>
<tr>
<td>• Shortness of breath at rest</td>
</tr>
<tr>
<td>• Severe orthopnea 2-4 pillows</td>
</tr>
<tr>
<td>• Resting HR ≥105 bpm</td>
</tr>
<tr>
<td>• Resting systolic BP ≥140 mm Hg</td>
</tr>
<tr>
<td>• Oxygen saturation ≤94% with or without personal history of CVD</td>
</tr>
</tbody>
</table>

| Personal History of CVD Without Red Flags |

| CONSULTATIONS with MFM and Primary Care/Cardiology |

**PROMPT EVALUATION and/or hospitalization for acute symptoms**

**How to manage?**

- **Severe Pre-eclampsia with Cardiomyopathy**
  - Transfer to tertiary care facility
  - Consult Cardiology
  - Consult MFM
  - Admit to hospital
  - Maternal Echocardiogram
  - Diurese
  - Control HTN and HR
  - Monitor I’s and O’s
  - Determine if MgSO4 is appropriate or not
  - Alternative anti-epileptic if indicated

**CVD Assessment Algorithm** (The Red Flags and/or no personal history of CVD, and hemodynamically stable)

### SYMPTOMS
- "Red Flags" class > 3
  - Severe Pre-eclampsia, cardiomyopathy and CHF
  - Symptoms/History
  - Vital signs
  - Abnormal Cr and LFTs
  - Elevated BNP
  - Pulmonary congestion with likely pulmonary edema
  - Consolidation is common red herring
  - EKG with R atrial stretch

### VITAL SIGNS
- Resting HR ≥105 bpm
- Systolic BP ≥140 mm Hg
- BS ≥25
- Oxygen sat <95%

### RISK FACTORS
- Age ≥40 years
- African American
- Pre-pregnancy obesity (BMI ≥30)
- Diabetes
- Hypertension
- Anemia
- History of preterm delivery

### PHYSICAL EXAM
- Edema
- JVD
- Chest congestion
- Lung Auscultations

### ABNORMAL FINDINGS
- Heart Lesions
- Murmur
- EKG

### WHAT IS BNP?
- B-type Natriuretic Peptide (also Brain Natriuretic Peptide)
- Released by cardiac ventricles due to stretch
- Increases natriuresis and diuresis
- Slight increase in pregnancy
- CMQCC considers anything <100 pg/ml is normal
- Cardiologists typically use >500 pg/ml as indicative of heart failure
- Renally cleared
  - Will be markedly elevated in patient with renal failure

### Future possibilities
- Cheetah NICOM
  - Used frequently for evaluating patients with severe sepsis/septic shock
  - Ability to monitor CO and SVR non-invasively
  - Interesting tool for diagnosis and monitoring recovery in Preeclampsia with Severe Features

I have no financial association and am not endorsing this product for non-FDA approved purposes.
Lessons were learned from the CA-PMR

CA-PMR Findings
Presentation of Women with CVD
2002 - 2006

- Only 2 women entered pregnancy with known CVD
- Prevalence of CVD symptoms (SOB, wheezing, palpitations, edema, chest pain, dizziness, or extreme fatigue)
  - Prenatal period: 43%
  - Labor and delivery: 51%
  - Postpartum: 80%

CA-PMR Findings
Contributing Factors & Quality Improvement Opportunities (2002-2006) for CVD

Health Care Provider Effect on Mortality
- Contributing to mortality in 69% of all cases
  - Delayed or inadequate response to clinical warning signs (61%)
  - Ineffective or inappropriate treatment (39%)
  - Misdiagnosis (37.5%)
  - Failure to refer or consult (30%)
- Quality Improvement Opportunities
  - Better recognition of signs and symptoms of CVD in pregnancy
    - Shortness of breath, fatigue
    - Tachycardia, blood pressure change, or low oxygen saturation
    - Improved management of hypertension

Key Points (1)
- Symptoms related to physiologic changes of pregnancy should be improving in the postpartum period.
- Any visits to Emergency Department for dyspnea should raise suspicion for cardiovascular disease.
- Women of childbearing age should be questioned about recent pregnancies, in addition to their last menstrual period (LMP).
- Postpartum dyspnea or new onset cough is concerning for cardiovascular disease.
Postpartum Presentations to the ED, PCP or OB Provider

Key Points (2)
- New onset asthma is rare in adults.
- Bilateral crackles on lung examination are most likely associated with Congestive Heart Failure (CHF).
- Improvement of dyspnea with bronchodilators does not confirm the diagnosis of asthma, as CHF may also improve with bronchodilators. Likewise, a lack of response to bronchodilators should prompt the entertainment of a diagnosis other than asthma.

CA-PAMR Conclusions
- Signs and symptoms of normal pregnancy / postpartum may mimic cardiac disease, but should be interpreted with caution when severe and occur in the presence of vital sign abnormalities and underlying risk factors.
- Most CVD was not diagnosed until after the women gave birth or had died.
- Increased awareness and index of suspicion for potential cardiovascular disease diagnosis, preconception counseling, and referral to higher level of care may help prevent adverse maternal outcomes.

What has MHS Done?
- Every pregnant patient has call parameters for severe BP on admit
- Protocol for treatment of severe HTN
- Order sets to ease use and mgmt
- Guidelines on mgmt of HTN and use of Magnesium Sulphate
- HTN warning signs will be/are now a part of discharge precautions
- Education, Education, Education
- More Coming SOON!
  * Peer Review

Thank You for Your Time
More Questions and Discussion!